

"On the High Temperature Standards of the National Physical Laboratory: an Account of a Comparison of Platinum Thermometers and Thermo-junctions with the Gas Thermometer." By J. A. HARKER, D.Sc., Fellow of Owens College, Manchester, Assistant at the National Physical Laboratory. Communicated by R. T. GLAZEBROOK, F.R.S. Received January 20,—Read February 11, 1904.

(From the National Physical Laboratory.)

(Abstract.)

This paper contains an account of a continuation of the work of Dr. P. Chappuis and the author,* on a comparison of the scale of the gas thermometer with that of certain specially-constructed platinum thermometers, from temperatures below zero up to the boiling point of sulphur, and in one case to a point close to 600° C.

The results of this work substantially confirm the experiments of Callendar and Griffiths, and show that the indications of the platinum thermometer may be reduced to the normal scale by the aid of Callendar's difference formula :

$$d = T - pt = \delta \left[\left(\frac{T}{100} \right)^2 - \frac{T}{100} \right],$$

where pt is the platinum temperature, T the temperature on the normal scale, and δ a constant which, for pure platinum, does not differ much from the value 1.5.

The temperatures chosen for the determination of δ are 0° C., 100° C., and the boiling point of sulphur.

In the present paper the work is extended to a temperature of 1000° C. Moreover, a number of standard thermo-junctions of platinum—platinum-rhodium were included in the comparisons.

The gas-thermometer employed for this work was presented to the laboratory by Sir Andrew Noble; it was obtained, along with materials for the electric furnaces and thermo-junctions, through the kindness of Dr. Holborn, of the Reichsanstalt. The bulbs used were of porcelain, glazed inside and out, and the gas used was pure dry nitrogen. The thermo-junctions, which were carefully compared by Dr. Holborn with the standards of the Reichsanstalt, at a number of fixed points up to 960° C., were again tested and compared together before use, with concordant results. A special potentiometer designed and made in the laboratory enabled the thermo-junction readings to be taken with great accuracy.

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The platinum thermometers employed were one of the three used by Harker and Chappuis in their earlier work, and a new one constructed in the laboratory as one of a number belonging to the British Association. The different instruments, after determination of their constants, were tested together in specially constructed electric resistance furnaces, heated from a special battery, in which temperatures from 400—1100° C. could be very steadily maintained for considerable periods. Special winding enabled a compensation to be made for the greater cooling effect at the ends of the furnaces, so that over a considerable length the temperature was exceedingly uniform.

The following table gives the results of one series of comparisons, and indicates the agreement obtained:—

Second Series of Comparisons. Compensated Furnace.

Gas Thermometer, Platinum Thermometer BA₂, Thermo-junction NPL₂.

No. of experiment.	Temperature.			G—Pt.	G—Th.	P—Th.
	Gas thermometer.	Junction.	Pt. thermometer.			
5	523·1	524·3	524·39	—1·3	—1·2	+0·1
10	568·5	569·5	569·35	—0·9	—1·0	—0·2
8	598·5	597·8	597·62	+0·9	+0·7	—0·2
1	599·4	599·0	598·80	+0·6	+0·4	—0·2
3	641·1	641·1	641·75	+0·6	+0·0	—0·6
4	682·4	683·0	682·54	—0·1	—0·6	—0·5
2	776·7	775·5	775·13	+1·6	+1·2	—0·4
9	820·0	818·4	818·31	+1·7	+1·6	—0·1
11	831·4	832·2	831·86	—0·5	—0·8	—0·3
12	866·7	868·4	868·28	—1·6	—1·7	—0·1
6	875·0	875·4	875·24	—0·2	—0·4	—0·2
7	959·8	956·0	955·47	+4·3	+3·8	—0·5
13	1005·0	1004·4	1004·37	+0·6	+0·6	—0·0

Thus the investigation shows that:

1. The readings of the platinum thermometers BA₂ and K₂, which may be taken as representative instruments, when reduced to the air scale by the use of Callendar's difference formula are, up to a temperature of 1000° C., in reasonably close agreement with the results obtained from the constant volume nitrogen thermometer, employing chemical nitrogen, and using the received value for the dilatation of the Berlin porcelain, of which the bulb is made.

2. The above platinum thermometers agree very closely with a set of thermo-junctions representing the temperature scale of the Reichsanstalt, and based on measurements with a gas thermometer having a bulb of platinum-iridium.

As the results of these experiments seem to justify very completely the use of Callendar's parabolic formula over a wide range, a table has been calculated by which the value of T may be obtained directly from the value of Pt for a range of temperature extending from -200 to $+1100^{\circ}$ C., and for the value 1.5 of the constant δ .

A second short table extends this to all values of δ usually met with. It is hoped that this table may be of general use to others who are employing platinum thermometers.

The experiments were carried out at the National Physical Laboratory, and, in conclusion, I wish to thank those members of the staff who have assisted in it.

"The Spectra of Antarian Stars in Relation to the Fluted Spectrum of Titanium." By A. FOWLER, A.R.C.S., F.R.A.S., Assistant Professor of Physics at the Royal College of Science, South Kensington. Communicated by Professor H. L. CALLENDAR, F.R.S. Received February 18,—Read March 3, 1904.

[PLATE 6.]

The distinguishing feature of the spectra of the Antarian Stars* is the system of apparently dark flutings, sharp towards the violet and fading off towards the red end of the spectrum. The principal flutings are well seen in Antares, but they are more strongly developed in the spectra of α Herculis and \circ Ceti, in which stars additional details are also seen. These flutings have not hitherto received a definite chemical interpretation, and it has been uncertain, owing to the possibly misleading effects of contrast, whether the spectrum was to be regarded as one consisting wholly of absorption flutings fading towards the red, or as one partly consisting of emission flutings fading in the opposite direction.

The purpose of the present communication is to state the nature of the evidence which indicates that the spectrum is essentially an absorption spectrum, and that the chief substance concerned in the production of the flutings is titanium, or possibly a compound of that element with oxygen.

The first indication of this result was the striking general resemblance of the titanium flutings, as seen in photographs recently obtained, with the stellar flutings, both as to relative intensity and apparent position (Plate 6). The interspaces between the flutings, as they appear on a negative, in some cases also strongly recall the corresponding bright spaces in the stellar spectra.

* Secchi's Type III; Vogel's Class IIIa.